

I. MANAGEMENT'S DISCUSSION AND ANALYSIS



A. AGENCY PROFILE

The National Science Foundation (NSF), as steward of America's science and engineering enterprise, is charged with supporting and strengthening all research disciplines and providing leadership across the broad and expanding frontiers of scientific and engineering knowledge. NSF's authorizing legislation—the National Science Foundation Act of 1950—directs the Foundation to initiate and support basic scientific research and research fundamental to the engineering process; programs to strengthen scientific and engineering research potential; education programs at all levels of science and engineering; and the establishment of an information base for science and engineering appropriate for development of national and international policy. Over time, other responsibilities that have been added include fostering and supporting the development and use of computers and other scientific methods and technologies; providing Antarctic research, facilities and logistic support; and addressing issues of equal opportunity in science and engineering.

Despite its relatively small size NSF has an extraordinary impact on America's scientific and engineering knowledge and capacity. Although NSF represents only 4 percent of the total federal budget for research and development, it accounts for one-fifth of all federal support for basic research and 40 percent of non-life science basic research at academic institutions. In several fields NSF is the lead federal source; e.g., in the social sciences NSF provides nearly one-half of federal funding for basic research and in mathematics and computer sciences, 75 percent.

The NSF Vision: Enabling the Nation's future through discovery, learning and innovation

During NSF's five decades of leadership, path-breaking advances in science and engineering knowledge have reshaped society and enabled the U.S. to become the most productive nation in the world. The returns on investment in science and engineering have been enormous. For example, economists have attributed the sustained economic prosperity and productivity growth of the nineties largely to technological innovation, and in particular to the spread of information technology. In turn, accelerated productivity has elevated the standard of living for America and western society to a quality of life beyond anything imagined just 50 years ago.

The NSF Strategic Plan notes that “realizing the promise of the 21st century will depend in large measure on today's investments in science, engineering and mathematics research and education.” No other time in history has this been more apparent. The events of September 11 clearly brought to the forefront that we are living in a society defined by and dependent on science and technology. The most prominent concerns that arose immediately in the aftermath of the September 11 events—airline security, bio-terrorism, failure of communication links, poisoned food and drinking water, assessment of damaged infrastructure—also depend on scientific and technical knowledge. There has been no other time in the postwar period when NSF's investments to catalyze progress in science and engineering have been more critical to securing the Nation's future.

What NSF Does and How We Do It

To achieve its mission to promote the progress of science, NSF invests in three strategic areas: People, Ideas, and Tools.

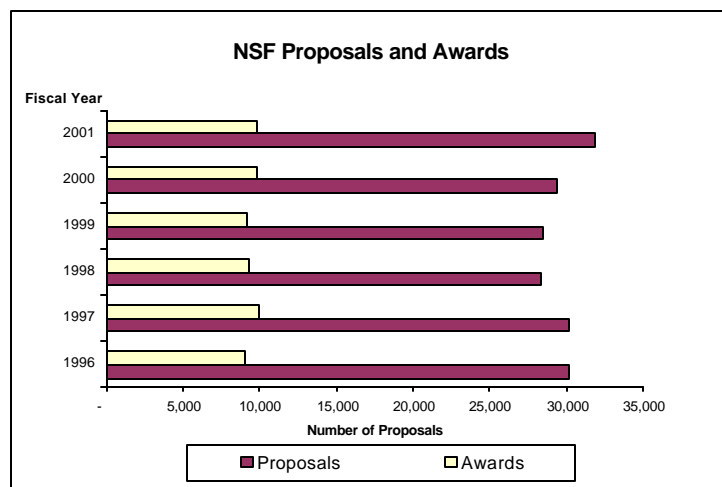
- **People:** Facilitating the creation of a diverse, internationally competitive and globally engaged workforce of scientists, engineers and well-prepared citizens is NSF's first priority. In order to achieve this goal, NSF supports improvement efforts in formal and informal science, mathematics, engineering and technology education at all levels—preK-12, undergraduate, graduate, professional development and public science literacy projects that engage people of all ages in life-long learning. NSF is also committed to enhancing diversity in the science and engineering workforce. The Foundation believes that enhancing the participation of individuals who are members of

underrepresented groups in the science and engineering workforce will not only further scientific progress by promoting diversity of intellectual thought but also meet the need for a technically trained workforce. Across its science, mathematics, engineering, technology research and education programs, NSF provides support for almost 200,000 people, including students, teachers, researchers, post-doctorates and trainees.

Number of People Involved in NSF Activities in FY 2001	
Senior Researchers	27,601
Other Professionals	9,904
Postdoctoral Associates	5,608
Graduate/Undergraduate Students	56,505
K-12 Students	11,335
K-12 Teachers	83,401
Total *	194,354
* Does not include individuals to be funded through H-1B Nonimmigrant Petitioner Receipts.	

- **Ideas:** Investments in “Ideas” support cutting edge research and education that yield new and important discoveries and promotes the development of new knowledge and techniques within and across traditional boundaries. These investments help maintain the Nation’s academic institutions at the forefront in science and engineering. The results of NSF-funded projects provide a rich foundation for broad and useful applications of knowledge and the development of new technologies. Support for Ideas also promotes the education and training of the next generation of scientists and engineers by providing them with an opportunity to participate in discovery oriented projects.
- **Tools:** NSF investments provide state-of-the-art tools for research and education, such as instrumentation and equipment, multi-user facilities, digital libraries, research resources, accelerators, telescopes, research vessels and aircraft, and earthquake simulators. In addition, resources support large surveys and databases as well as computation and computing infrastructures for all fields of science, engineering and education. Support for these unique national facilities is essential to advancing U.S. research and education, with the need driven predominately by research opportunities and priorities. NSF-supported facilities also stimulate technological breakthroughs in instrumentation, and are the site of research and mentoring for many science and engineering students.

NSF itself does not conduct research or operate laboratories. Instead, NSF’s role is that of a catalyst—seeking out and funding the best ideas and most capable people, making it possible for these researchers to pursue new knowledge, discoveries and innovation. Each year NSF receives approximately 30,000 proposals, of which about one in three are funded. In FY 2001, of the 31,902 proposals submitted 9,882 awards were made to nearly 2,000 colleges, universities, and other institutions—public, private, state, local and federal—throughout the U.S.



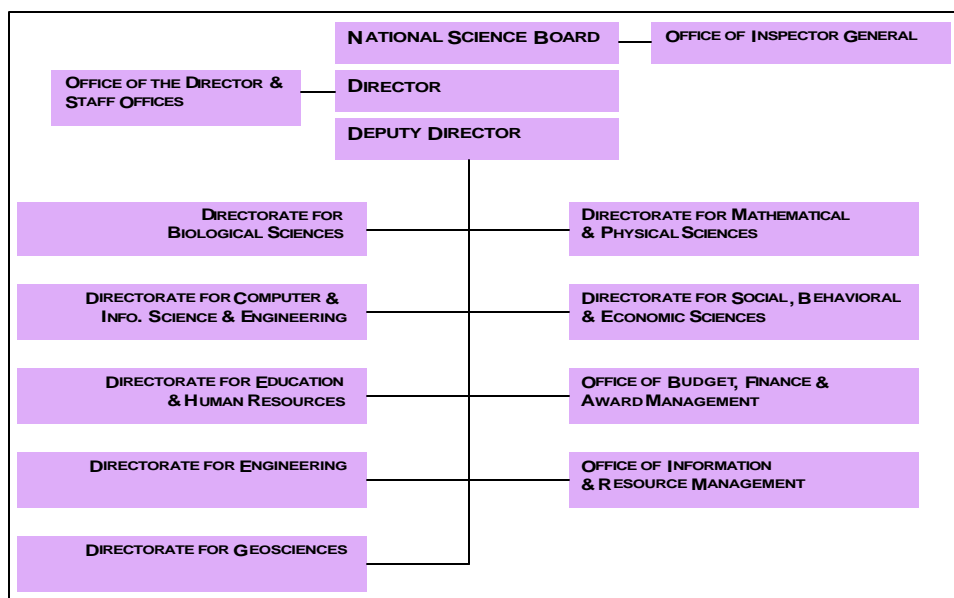
Nearly 90 percent of NSF funding is allocated through a merit-based competitive process that is critical to fostering the highest standards of excellence and accountability—standards for which NSF is known the world over. Each year more than 200,000 merit reviews involving nearly 40,000 external reviewers from all segments of the science, engineering, mathematics and education communities help NSF program officers evaluate the proposals submitted. Reviewers focus on two primary criteria—what is the intellectual merit of the proposed activity and what are its broader impacts, e.g., how well does the activity promote teaching, training, and learning. Reviewers also consider how well the proposed activity fosters the integration of research and education and broadens opportunities to include a diversity of participants, particularly underrepresented groups.

Organization Structure

NSF is headed by a director appointed by the President and confirmed by the U.S. Senate. NSF's current director, distinguished biologist Dr. Rita R. Colwell, became NSF's eleventh director in 1998. Dr. Colwell holds the distinction of being the first woman to head the Foundation. A 24-member National Science Board (NSB) oversees the policies and programs of the Foundation. NSB members, prominent contributors to the science, mathematics, engineering and education communities, are also appointed by the President with the consent of the Senate. The NSF director is a member *ex officio* of the Board. Both the director and NSB members serve six-year terms. The Board also serves the President and the Congress as an independent advisory body on policies related to the U.S. science and engineering enterprise.

NSF is structured much like an academic institution, with divisions organized by disciplines and fields of science and engineering, and for science, math, engineering and technology education. There are seven operating directorates, an Office of Polar Programs and two business offices. See Appendix 1 for a more detailed description of each directorate and business office.

NSF is funded primarily by Congressional appropriations and maintains a staff of about 1,200. To ensure that science and engineering funded by the Foundation remains at the frontier of the research enterprise, NSF utilizes the Intergovernmental Personnel Act (IPA) and Visiting Scientists, Engineers and Educators (VSEE) programs to regularly recruit outstanding scientists, engineers and mathematicians to serve short-term appointments, who bring with them new and innovative ideas.



Management Operations: A Center of Excellence and a “Green Light” for Financial Management

In a speech last fall at the National Press Club, White House Office of Management and Budget (OMB) Director Mitch Daniels lauded NSF as a model of administrative efficiency. He called the Foundation, “a true center of excellence” for its low overhead costs—5 percent of its total budget—and proposal review process that disseminates tax dollars through a merit-based competitive process to researchers pursuing the frontiers of science. As an example of performance results, Daniels noted that eight of the twelve most recent Nobel Laureates were supported by NSF.

As part of the Administration’s agenda to improve management in the federal government, OMB developed a scorecard to rate agencies in five areas. OMB noted that the Foundation received a better baseline evaluation than most other agencies, and in fact, NSF was the only agency to receive a “green light”—for meeting the OMB-defined core criteria in financial management. NSF was also cited as a federal government leader for E-Government and information technology. NSF’s management scorecard can be found in Appendix 2.

The growing demands on NSF, however, will require the Foundation to further improve its management operations. Over the past decade, as the agency’s budget has increased over 80 percent and workload and program responsibilities have increased both in terms of volume and complexity, onboard staff has remained essentially flat. In order to accommodate the increased workload as well as better serve our diverse and growing customer base, NSF has been engaged in an ongoing effort to streamline its work processes, invest in systems and infrastructure improvements, and better deployment of human and capital resources.

NSF’s pursuit of advanced information technologies to facilitate business transactions with the academic research community has produced impressive results. In FY 2001, virtually all grant proposals were submitted electronically; NSF is currently the only federal research agency receiving proposals electronically on a production basis. Along similar lines, 99 percent or \$3.2 billion of NSF’s financial payments to grantees were transacted electronically.

In FY 2001, NSF also made significant strides in enhancing program, accounting and financial business delivery systems. Implementation of the Program Announcement Template (PATs) has streamlined the way program announcements and solicitations are developed; a user can “walk through” preparation of a program announcement on a Web-based system. A new client/server platform system integrates the personnel system (“IPERS”), the payroll system (“IPAY”) and the time and attendance system (“ITAS”) and interfaces with NSF’s Financial Accounting System. The new IPAY system allows for electronic transfers of payroll and financial information to other government agencies and commercial financial institutions as well as incorporates employee electronic self-service capabilities. By reducing data entry requirements, eliminating manual reconciliations and making data available to employees online via their personal computer, IPAY enhances the entire payroll process.

Finally, in FY 2001, the agency’s CFO and CIO collaborated to establish a new Business and Operations Advisory Committee to provide external input to NSF’s business and management operations practices. The broad range of expertise offered by members of the Advisory Committee will aid NSF to poise itself to meet the administrative and management challenges of the 21st century.

The Foundation is committed to making and implementing effective management, stewardship and policy and program decisions. NSF adheres to the highest standards of management efficiency and integrity and in its pursuit of excellence and efficiency, assumes a pro-active role in meeting its management challenges. Looking ahead, in the immediate future, significant challenges to be addressed include accommodating new functions, processes and increased workload; better human capital management to sustain a high-performing workforce; increased emphasis on leadership and succession planning; and better oversight, management and accountability of larger, more complex interdisciplinary program activities and large infrastructure projects. The *President’s Management Agenda* initiatives dealing with Human Capital, Competitive Sourcing, Improved Financial Management, E-Government, and Budget/Performance Integration are high priorities for the Foundation.

B. FY 2001 PERFORMANCE RESULTS ¹

This is the third year NSF is reporting GPRA (Government Performance and Results Act of 1993) performance results. NSF began implementing GPRA in 1997, by developing an agency GPRA Strategic Plan. In September 2000, NSF updated the Strategic Plan to cover the period FY 2001-2006, and established three new strategic areas of focus, which directly translate into three strategic outcome goals—People, Ideas and Tools (PIT). The new PIT strategic areas of focus provide the guiding framework for NSF's FY 2001 Annual Performance Plan as well as NSF's FY 2001 Budget, which were developed concurrently to ensure a direct link between programmatic activities and the achievement of NSF's strategic outcome goals.

GPRA implementation has been a particular challenge for agencies like NSF whose mission involves research activities. This is primarily due to: (1) the difficulty of linking research outcomes to annual investments and the agency's annual budget; it is not unusual for research outcomes to appear years or decades after the initial investment, and (2) the fact that assessing the results of research is inherently retrospective and requires qualitative judgment of experts. NSF has developed an alternative format that has been approved by OMB, using external expert review panels to assess research results and reporting research outcome goals utilizing a qualitative scale. The use of external expert panels to review research results and outcomes is a common, long-standing practice used by the academic research community.

NSF's Performance Goals

NSF has three mutually supportive sets of performance goals and measures—for Strategic Outcomes, for Management and for Investment Process.

- **Strategic Outcome Goals:** To accomplish the NSF mission to promote the progress of science, NSF invests in the best People, with the best Ideas and provides them with the Tools they need. NSF's outcomes from its grants and cooperative agreements provide evidence of the success of NSF's investments in People, Ideas and Tools.^{2,3}
- **Management Goals:** For FY 2001, NSF's management goals focus on some of the critical factors in the Foundation's managing for excellence including exemplary use of, and broad access to, new and emerging technologies for business application; a diverse, capable, motivated staff that operates with efficiency and integrity; and a quality work life and work environment for its employees.
- **Investment Process Goals:** The Investment Process Goals focus on the means and strategies NSF uses to achieve its Outcome Goals and set performance targets for the investment processes by which NSF shapes its portfolio of awards. NSF's Investment Process Goals focus on the proposal and award process; broadening participation; and facilities oversight.

The longer term desired results of NSF awards are reflected in the Outcome Goals. Achieving the desired Outcome Goals depends in part on the quality of the investment process, which is related to the efficiency and effectiveness of the agency's administration and management. The Investment Process Goals and Management Goals are necessary to ensure that the longer term Outcome Goals will be achieved. NSF's Strategic Plan emphasizes three core strategies that are critical to achieving the strategic outcomes—

¹ For a comprehensive discussion of NSF's performance goals, final results and related issues, see *NSF's FY 2001 GPRA Performance Report* (www.nsf.gov/od/gpra/).

² See Appendix 3 for a discussion of how NSF research results are assessed.

³ Pages 15-22 provide examples of outcomes and results that emerged in FY 2001 from NSF investments in research and education activities made in prior years.

developing intellectual capital, integrating research and education, and promoting partnerships. They guide the agency in establishing priorities, identifying opportunities and designing new programs and activities. NSF's primary means for success is through use of a rigorous merit review process in making awards for activities that will influence research and education in math, science and engineering, both directly and indirectly.

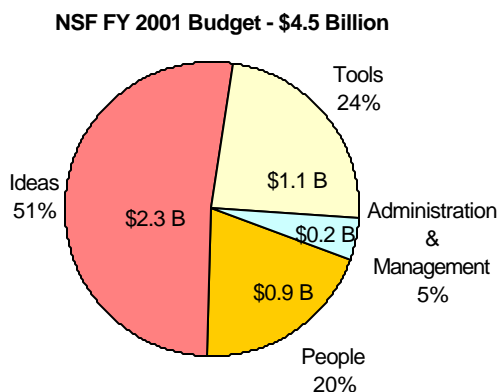
How Performance Goals are Linked to the Budget Structure

NSF receives five Congressional appropriations: Research and Related Activities (R&RA); Major Research Equipment (MRE); Education and Human Resources (EHR); and Salaries and Expenses (S&E). The fifth appropriation funds the Office of Inspector General. The following chart shows the appropriations that provide support for each of the Strategic Outcome Goals of People, Ideas and Tools. About 95 percent of NSF's budget goes directly to investments that support the Strategic Outcome Goals.

It is notable, however, that NSF's investments in support of its strategic outcomes of People, Ideas and Tools sometimes serve multiple purposes. For example, the involvement of graduate students in research projects not only generates new ideas and prepares them for entry into the workforce, but it often involves them in the development of new tools.

<i>How NSF's FY 2001 Appropriations Are Linked to NSF's Strategic Outcome Goals</i>	
<i>Appropriation</i>	<i>Strategic Outcome Goal</i>
<i>Education and Human Resources (\$612M)</i> <i>Research and Related Activities (\$283M)</i>	<i>People: Develop a diverse, internationally competitive and globally engaged workforce of scientists, engineers and well-prepared citizens.</i>
<i>Research and Related Activities (\$2.2B)</i> <i>Education and Human Resources (\$144M)</i>	<i>Ideas: Enable discovery across the frontier of science and engineering, connected to learning, innovation and service to society.</i>
<i>Research and Related Activities (\$911M)</i> <i>Major Research Equipment (\$119M)</i> <i>Education and Human Resources (\$25M)</i>	<i>Tools: Provide broadly accessible, state-of-the-art and shared research and education tools.</i>
<i>Salaries and Expenses (\$166M)</i> <i>Office of Inspection General (\$7M)</i> <i>[In the Statement of Net Cost the indirect support activities funded by the Salaries and Expenses and Inspector General appropriations are prorated among People, Ideas and Tools based on each program's direct cost.]</i>	<p>People, Ideas, Tools</p> <p>[See below; the S&E Appropriation supports NSF's Management and Investment Process Goals, which support the achievement of the Strategic Outcome Goals.]</p>

In FY 2001, support for the three Strategic Outcome Goals of People, Ideas and Tools totaled \$894 million, \$2.3 billion, and \$1.1 billion, respectively.



NSF's Management and Investment Process Goals focus on the internal operations and activities of the agency—e.g., processing proposals and merit review—which enable the achievement of our mission. The Management and Investment Process Goals are primarily supported by the S&E appropriation. There is also R&RA and EHR funding that directly support limited program support activities. To capture the administration and management activities that support achievement of the Strategic Outcome Goals, in the Statement of Net Cost, S&E is prorated among People, Ideas and Tools based on each program's direct cost. The OIG appropriation is treated similarly.

<i>How NSF's FY 2001 Appropriations Are Linked to NSF's Management and Investment Process Goals</i>	
<i>Appropriation</i>	<i>Performance Goal</i>
<i>Salaries and Expenses (\$161M)</i> <i>[In the Statement of Net Cost, S&E is prorated among People, Ideas and Tools to account for its contribution to the achievement of the outcome goals.]</i> <i>R&RA (\$26M)</i> <i>EHR (\$15M)</i>	<p>Management Goals</p> <p>Investment Process Goals</p>

Data Verification and Validation

For the second consecutive year, NSF engaged an independent, external consulting firm—PricewaterhouseCoopers LLP (PwC)—to conduct verification and validation review of selected performance measures. PwC's assessment was based on criteria established by the General Accounting Office's *Guide to Assessing Agency Annual Performance Plans (GAO/GCD-10.1.20)*. PwC assessed the accuracy of

NSF's performance measures, described the reliability of the processes NSF uses to collect, process, maintain and report data; reviewed system controls to confirm that quality input results in quality output; and identified changes to processes and data for those goals undergoing review for the second time. For the goals undergoing review for the first time, PwC documented the processes NSF follows to collect, process, maintain and report performance data. PwC also identified relevant controls and commented on their effectiveness.

In their report, PwC asserts the following: "We commend NSF for undertaking this second year effort to confirm the reliability of its data and the processes to collect, process, maintain and report this data. From our FY 2001 review, we conclude that NSF has made a concerted effort to ensure that it reports accurately to the federal government and has effective systems, policies, and procedures to ensure data quality. We have noted some areas for improvement, particularly in the area of data collection for the goals related to facilities management. However, overall NSF relies on sound business practices, system and application controls, and manual checks of system queries to report performance. Further, our efforts to re-calculate the Foundation's results based on these systems, processes and data were successful."

The PwC study concluded that NSF reported on ten of the quantitative goals and all five qualitative goals "in a manner such that any errors, should they exist, would not be significant enough to change the reader's interpretation of the Foundation's success in meeting the supporting performance goal. For these goals, NSF relies on sound business processes, system and application controls, and manual checks of system queries to report performance. We believe that these processes are valid and verifiable." For the four goals related to facilities management, PwC identified data limitations that did not allow verification of the processes, however, PwC was able to validate that NSF's outcomes were consistent with the data that was collected. NSF will consider the recommendations made by PwC in its continuing efforts to improve data collection and reporting processes.⁴

Summary of FY 2001 Performance Results

<i>Performance Goal</i>	<i>Number of Goals Achieved in 2001</i>	<i>Number of Goals Achieved in 2000</i>
Strategic Outcome Goals	4 out of 5 (80%)	6 out of 8 (75%)
Management Goals	4 out of 5 (80%)	5 out of 6 (83%)
Investment Process Goals	7 out of 13 (54%)	7 out of 14 (50%); one goal was not applicable
Total	15 out of 23 (65%)	18 out of 28 (64%)

In FY 2001, NSF achieved 15 of 23 performance goals, or 65 percent. Overall, these results are similar to the prior year results, when NSF achieved 64 percent of its performance goals. The following is a discussion of selected key FY 2001 performance goals and results; see Appendix 4 for a performance chart that includes all of NSF's FY 2001 GPRA performance goals and results. For a comprehensive discussion

⁴ For a more detailed discussion of verification and validation of NSF's GPRA results, see *NSF's FY 2001 GPRA Performance Report*.

of NSF's GPRA performance goals, results and related issues, see NSF's *FY 2001 GPRA Performance Report*.

1. Strategic Outcome Goal – Ideas: Enabling discovery across the frontier of science and engineering, connected to learning, innovation, and service to society.

Investments in ideas support cutting edge research that yields new and important discoveries and promotes the development of new knowledge and techniques within and across traditional boundaries. These investments enable NSF to meet its mission of promoting the progress of science while at the same time helping to maintain the Nation's capacity to excel in science and engineering, particularly in academic institutions. The results of NSF-funded research projects provide a rich foundation for broad and useful applications of knowledge and the development of new technologies. Support in this area also promotes the education and training of the next generation of scientists and engineers by providing them with an opportunity to participate in discovery-oriented projects. NSF-funded centers provide an enhanced environment for broad interdisciplinary education at all levels. On pages 15-22 are examples of results and outcomes that emerged in FY 2001 from NSF investments in research and education activities made in prior years.

Performance Goal for "Ideas" outcome: NSF's performance is successful when, in the aggregate, results reported in the period demonstrate significant achievement for one or more of the following indicators: (1) a robust and growing fundamental knowledge base that enhances progress in all science and engineering areas including the science of learning; (2) discoveries that advance the frontiers of science, engineering and technology; (3) partnerships connecting discovery to innovation, learning and societal advancement; and (4) research and education processes that are synergistic.

Baseline: This is a new goal.

Results: This goal was achieved. Reports prepared by external experts during FY 2001 GPRA reporting provide assessments and retrospective examples of NSF-supported projects that document significant achievement.⁵ NSF's key strategy for success is to support the most promising ideas in research and education, as identified through merit review of competitive proposals. Innovation and creativity, cooperative research through partnerships, and education and training are emphasized and encouraged.

⁵ For a more detailed explanation of how research results are assessed, see Appendix 3.

2. Management Goal – Electronic Proposal Submission: In FY 2001, 95 percent of full proposals will be received electronically through FastLane.

FastLane is a collection of modules that streamlines and re-engineers the Foundation's interactions with the research community by allowing transactions and communications between NSF and its grantees to be facilitated via the Internet. Under development as a research project since 1994, the goal was to provide a paperless environment by the end of FY 2001. To achieve this, the annual GPRA goal has been progressively more stringent, and through a combination of educational initiatives and technical assistance we have successfully reached our goal each year. For FY 2001, the goal was exceeded.

<p><u>Performance Indicator:</u> Percent of full proposals received electronically through FastLane.</p> <p>FY 1998 Baseline: 17%</p> <p>FY 1999 Result: 44%</p> <p>FY 2000 Goal: 60%</p> <p>FY 2000 Result: 81%</p> <p>FY 2001 Goal: 95%</p> <p>FY 2001 Result: 99%</p>	<p>RESULTS: This goal was achieved.</p> <p>FastLane has been universally accepted by NSF's external customers for proposal submission. NSF's outreach program continues to educate and inform external customers as well as provide assistance for those customer groups who might have difficulty or limited technical access for electronic submission. The electronic signature capability has enabled virtually 100% complete electronic submissions. As a result, we have achieved this goal and will no longer monitor it in future GPRA Plans.</p> <p>NSF is the only federal research agency currently receiving proposals electronically on a production basis.</p>
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3. Investment Process Goal – Use of Merit Review: At least 85 percent of basic and applied research funds will be allocated to projects that undergo merit review.

<p><u>Performance Indicator:</u> Percent of project funding that has undergone merit review.</p> <p>FY 2000 Goal: 80%</p> <p>FY 2000 Result: 87%</p> <p>FY 2001 Goal: 85%</p> <p>FY 2001 Result: 88%</p> <p>[During FY 2000, OMB redefined what constitutes a merit-reviewed project and established a new target level of 70-90 percent.]</p>	<p>RESULTS: This goal was achieved.</p> <p>NSF's merit review process is the keystone for award selection. NSF evaluates proposals for research and education projects using two criteria – the intellectual merit of the proposed activity and the broader impacts of the proposed activity on society. The criteria now in place, established by the National Science Board, were revised in 1998 to simplify and harmonize them with the Strategic plan. Both support NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense."</p>
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4. Investment Process Goal–Time to Decision: For 70 percent of proposals, be able to tell applicants whether their proposals have been declined or recommended for funding within six months of receipt.

Customer Service Standard: This customer service standard was established in response to a survey of NSF applicants who indicated that processing proposals within six months of receipt was valued highly. Processing proposals within six months of receipt remains a challenging goal for NSF.

<p><u>Performance Indicator:</u> Percent of proposals processed within six months:</p> <p>FY 1998 Baseline: 59%</p> <p>FY 1999 Goal: 70%</p> <p>FY 1999 Result: 58%</p> <p>FY 2000 Goal: 70%</p> <p>FY 2000 Result: 54%</p> <p>FY 2001 Goal: 70% FY 2001 Result: 62%</p>	<p>RESULTS: This goal was not achieved. In FY 2001, NSF processed 62% of all proposals within six months. This performance improves upon the FY 1998 baseline of 59% but is still short of the 70% goal. Data shows that about 77% of proposals were processed in less than seven months and over 90% were processed in less than nine months.</p> <p>During FY 2001, NSF took a number of important steps to reduce processing time. A series of new electronic processes designed to improve the efficiency and effectiveness of the proposal review process was implemented. New FastLane modules such as the Interactive Panel System and Electronic Declination, as well as the pilot project to provide proposals to reviewers electronically with print-on-demand available, are reducing processing time and helping NSF staff cope with increasing workload.</p> <p>In addition, NSF sponsored a series of brainstorming sessions for staff at all levels to discuss issues and effective practices related to proposal processing time. The results of these sessions, including effective practices employed by organizations with excellent processing times, were widely disseminated throughout NSF. These sessions also identified a number of key management issues related to processing time such as the need for timely processing of declinations and better tracking information on proposals in process. A report was developed that tracks proposals through major processing stages and identifies those that are close to exceeding recommended time frames for each stage. This report is produced centrally and periodically distributed to division directors throughout NSF.</p> <p>In FY 2002, NSF will continue to focus on improving the efficiency of proposal processing, including the dissemination of best practices to program staff.</p>
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5. Investment Process Goal–Award Size: NSF will increase the average annualized award size for research projects to a level of \$110,000. (Note this target is only applicable to competitive research grants, a subset of awards that focuses on awards to individual investigators and small groups.)

<p><u>Performance Indicator:</u> Annualized award size of research projects.</p> <p>FY 1998: \$90,000</p> <p>FY 1999: \$94,000</p> <p>FY 2000: \$105,800</p> <p>FY 2001 Goal: \$110,000 FY 2001 Result: \$113,601</p>	<p>RESULTS: This goal was achieved.</p> <p>This was a new goal for FY 2001.</p> <p>The issue of award size continues to be a concern for NSF. With larger award size, researchers are able to devote a greater portion of their time to productive research. Adequate award size is important both to getting high quality proposals and to ensuring that proposed work can be accomplished as planned.</p> <p>In FY 2002, increasing award size remains a priority; a higher target will be set.</p>
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6. Investment Process Goal – Award Duration: NSF will increase the average duration of awards for research projects to at least three years.

<p><u>Performance Indicator:</u> Average duration of research projects.</p> <p>FY 1998 Baseline: 2.7 years</p> <p>FY 1999 Goal: 2.8 years</p> <p>FY 1999 Result: 2.8 years</p> <p>FY 2000 Goal: n/a</p> <p>FY 2000 Result: 2.8 years</p> <p>FY 2001 Goal: 3.0 years</p> <p>FY 2001 Result: 2.9 years</p> <p>(This goal was dropped in FY 2000 but reinstated for FY 2001.)</p>	<p>RESULTS: This goal was not achieved.</p> <p>The issue of award duration continues to be an ongoing concern for NSF. With longer duration, researchers are able to devote a greater portion of their time to productive research. Adequate award duration is important both to obtaining high quality proposals and to ensuring that proposed work can be accomplished as planned.</p> <p>In FY 2002, this goal remains a priority.</p>
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7. Investment Process Goal – Operations and Management of Facilities: For 90 percent of facilities, keep operating time lost due to unscheduled downtime to less than 10 percent of the total scheduled operating time.

<p><u>Performance Indicator:</u> Comparison to scheduled operating time.</p> <p>FY 1999 Result: Inconclusive.</p> <p>FY 2000 Result: Goal not achieved. Of the 26 facilities, most met the goal of keeping unscheduled downtime to below 10% of the total scheduled operating time.</p> <p>FY 2001 Result: Of the 29 facilities, 25 (86%) met the goal of keeping unscheduled down time to below 10% of the total scheduled operating time. Four reported unscheduled downtime greater than 10%. Of those four, two facilities reported unscheduled downtime within 14% of the total scheduled operating time.</p>	<p>RESULTS: Goal was not achieved.</p> <p>Some causes for failure to achieve this goal were outside the control of the facility, such as electric power supply interruption and equipment failure. Other causes ranged from sub-par performance of new instruments early in their commissioning to unanticipated equipment failure and downtime for repairs.</p> <p>In FY 2002, NSF will continue to work with awardees to identify obstacles to successful performance and develop plans to avoid or mitigate their consequences in the future.</p>
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An Impressive Return on Investments

The following examples illustrate the impact and success of NSF's investments in People, Ideas and Tools. NSF supports cutting edge research that yields new discoveries over time. These discoveries are essential for maintaining the Nation's capacity to excel in science and engineering and lead to new and innovative technologies that benefit society. Because many research results appear long after the period when the investment is made, these are outcomes and results of NSF support of research and education projects made in prior years but which emerged in FY 2001.⁶

Scientists Find Unexpected Life Forms, Structures in Oceans Around the Globe: Scientists exploring a remote area of the central Indian Ocean seafloor 2½ miles deep have found animals that look like fuzzy snowballs and chimney-like structures two stories tall spewing super-heated water full of toxic metals. Another team in the northern Pacific has found astounding numbers of *archaea*, a microscopic life form distinct from plants and animals once thought to exist only in extremely hot or acidic environments. Yet another team in the Atlantic has found hydrothermal vents towering 180 feet above the ocean floor.

An NSF-supported team of 34 scientists and engineers from a dozen institutions explored the Indian Ocean aboard the Woods Hole Oceanographic Institution's 279-foot research vessel *Knorr*. They deployed instruments like the remotely operated vehicle, *Jason*, to explore temperature variations, which led them to the discovery of the hydrothermal vents resembling smokestacks and sea anemones resembling snowballs. David Karl, Markus Karner, and Edward DeLong of the NSF-sponsored Hawaii Ocean Time-series project sampled the northern Pacific Ocean from the surface to 4,750 meters deep and found that *archaea* may make up to 50 percent of the biomass in the open sea.

Another expedition of scientists from the Scripps Institution of Oceanography, Duke University, the University of Washington, and other institutions explored a mid-Atlantic mountain ridge. The towering hydrothermal vents they discovered are the largest ever observed. They are also unique in their composition of carbonate material and silica and the fact that dense macrofaunal communities such as clams, shrimps, mussels, and tube worms, which typify most other mid-ocean ridge hydrothermal environments, are absent in this field.

The findings may provide critical answers to long-standing questions about the diversity of life in the deep sea, how the oceans function ecologically, how animals move from place to place, and how the ocean crust is changing.

"Silent" DNA Speaks up for the First Time: By moderately raising the temperature of cells, biologists have broken through what was considered an impermeable barrier that kept half the genes in some cells "silent." The surprising results, in which these heated genes reached 500 times their normal rate of expression, could lead to better understanding of cellular processes involved in aging, fever, and toxicity.

Biochemistry and molecular biology professor David Gross and graduate student Edward Sekinger conducted the research at Louisiana State University Health Science Center (LSUHSC) with NSF support. Their findings appeared in the May 2001 issue of the journal *Cell*.

The process that makes some genes silent could itself help scientists understand aging. These findings could turn the gene-expression field upside down. Apart from the possible implications for aging, the research could eventually help explain why certain cells are more vulnerable to fever and toxic chemicals, and how to control their negative effects.

Big City Students Make Gains in Math and Science: In 1993, NSF undertook a bold initiative to encourage and invest in system-wide reform of K-12 mathematics and science education in some of the most

⁶ For additional examples of results and outcomes of NSF's investments, see the NSF's Office of Legislative and Public Affairs Website at www.nsf.gov/od/lpa/.

disadvantaged urban school systems. Students in these systems were performing poorly in mathematics and science, with wide gaps evident between minority and majority students. NSF introduced Urban Systemic Initiatives (USI) to enable cities to implement wide-ranging reforms through standards-based curricula, professional development for teachers, and accountability for achievement through data collection and assessment. Now, an external evaluation team reports some dramatic payoffs to these investments.

Academic Excellence for All Urban Students, a summary report on urban programs making up NSF's USI, shows that students in most of the 22 cities where school systems undertook reform efforts are making progress in several areas. The report is part of a larger, ongoing NSF-funded evaluative study. The study has found that in most of the USI cities, students are taking more math and science courses and increasing achievement levels, demonstrated through various assessment tools. Minority students, meanwhile, are making even greater gains in enrollments and performance, reducing the "achievement gap" between themselves and majority students.

These preliminary indicators give insights into what can happen when school systems use investments wisely to support system-wide policies for learning, to develop capabilities of teachers, and to connect with the community through partnerships. Great returns on those investments are possible when all of the pieces fit together.

Synthetic Clay Could Assist Radioactive Waste Cleanup: Researchers at Pennsylvania State University completed an important step in the drive to remove harmful materials from waste streams and drinking water. A team led by Sridhar Komarneni, professor of clay mineralogy, demonstrated that a synthetic clay known as swelling mica has the ability to separate ions of radium, a radioactive metal, from water. The finding could have implications for radioactive and hazardous waste disposal, particularly in the cleanup of mill tailings left over from the processing of uranium for the Nation's nuclear industry. The tailings contain radium and heavy metals that can leach into groundwater and contaminate drinking water supplies.

The swelling mica, known as Na-4, is one of a group of clays not found in the natural environment. Created specifically for water treatment purposes, swelling micas expand as they absorb metal ions and then, reaching their capacity, collapse and seal the contaminants inside. The swelling micas are being explored for potential use in separating ions of heavy metals such as lead, zinc, and copper as well as other radioactive materials, including strontium, from waste streams. Because they trap the ions, the micas can permanently immobilize the pollutants. They could prove useful for the recovery and recycling of valuable metals as well.

Full of Holes: Scientists developing photonic devices for optical and electronic applications may get a boost from a new process for "cutting" 3-D arrays of holes in a polymer material. Researchers found a way to create an orderly pattern of air bubbles throughout a polymer film using a simple solvent. By controlling the polymer, solvent, humidity, and flow of air across the polymer, scientists can trigger a condensation of tiny uniform water droplets. The droplets sink into the polymer film. The process repeats itself on its own until the film is filled with a three dimensional array of water bubbles. When the solvent and water evaporate, they leave behind a polymer scaffold with a lattice of equal-sized air bubbles.

The process could contribute to the development of optical switches and the ability to direct or "steer" light beams, just as electrical switches and conducting materials control and direct electrical current. Potential applications include lasers, antennas, millimeter wave devices, and solar cells. This discovery represents an easy way of making materials with the regular structure needed for optical and photonic applications in a completely self-assembled process.

Researcher Mohan Srinivasarao, a physical polymer chemist in the Georgia Institute of Technology's textiles and fiber engineering department, is an NSF CAREER awardee. The Foundation-wide CAREER program recognizes and supports the early career-development activities of those teacher-scholars who are most likely to become the academic leaders of the 21st century. CAREER awardees are selected on the

basis of creative, career-development plans that effectively integrate research and education within the context of the mission of their institution.

Superconductivity: Making it Work in the Real World: A new high-temperature superconductor found in January 2001 by a Japanese team in a simple, commonly available compound has profound potential for future uses. U.S. scientists at an NSF materials research center at the University of Wisconsin, in collaboration with an NSF-funded solid-state chemistry group at Princeton University, have shown that the compound, magnesium diboride or MgB_2 , will be useful for real-world applications such as electronics, communications, and industrial tasks that would benefit from the passage of large amounts of current with no resistance.

Superconductors are materials that lose all their resistance to electrical current flow below a certain critical temperature. The higher the critical temperature, the more useful the material for practical applications. MgB_2 's critical temperature at 39 Kelvin is lower than other candidate materials—generally copper oxides—but has other properties that this team says make it a “go.”

In the copper oxide superconductors discovered so far, the interfaces between the crystals of the material—the so-called “grain boundaries”—interfere with the efficient flow of current, severely limiting their usefulness. In the case in MgB_2 , this research team has shown the current passes smoothly between the crystal grains. One of the unfulfilled promises of previously known copper-oxide superconductors is the commercial production of wires carrying large amounts of current for everyday applications. Potential applications include magnetic resonance imaging (MRI) devices, more efficient power transmission lines, and a variety of electronic devices.

The Birth of the Universe: Two teams of cosmologists released new findings about the nature of the universe in its infancy. Their spectacular images of the cosmic microwave background (CMB), taken with instruments operating from Antarctica, reveal the strongest evidence to date for the theory of inflation, the leading model for the formation of the universe. The announcement represents the first release of data from the Degree Angular Scale Interferometer, a 13-element ground-based instrument operating since last year at the NSF Amundsen Scott South Pole Station. Scientists also released similar results from further analysis of data from the Balloon Observations of Millimetric Extragalactic Radiation and Geophysics project, obtained in 1998 and first reported in 2000.

These spectacular results represent a payback from the significant national investment in research in the polar regions. The Antarctic environment provides exceptional clarity for astrophysical observations, and the U.S. Antarctic Program provides unmatched support for world-class research. Both analyses, unveiled at the American Physical Society meetings, support the model that the universe experienced a tremendous spurt of growth shortly after the Big Bang. Cosmologists believe the structures that formed in the very first moments of the cosmos left their imprint as a very faint pattern of variations in the temperature of the CMB, the radiation left over from the intense heat that filled the embryonic universe during the initial growth spurt. Some 12–15 billion years later, these temperatures have become detectable from Earth with highly sensitive instruments. Multiple teams supported by NSF have probed the CMB for these minute temperature variations, including the two teams operating from the polar region. Two other teams using instruments in the continental United States also released data.

This is an outstanding example of how NSF supports multiple scientific projects, leading to rapid, new results. It took more than a decade to get the initial observations of the cosmic microwave background with the COBE satellite, and in only a few short years, the progress in sharpening those observations has been truly astounding.

The teams used independent methods and two different technologies to obtain detailed observations of the CMB. The observations have provided so much data that new methods had to be invented to analyze them. As the data analyses continue, they are providing precise measurements of parameters that cosmologists

have long used to describe the early evolution of the universe, but in the past could only illustrate with models.

Genome Sequencing Yields Many Insights: Genetics reached a major milestone in December 2000 as an international research team announced it had completed the first plant genome sequence. The species *Arabidopsis thaliana* has emerged as the plant counterpart of the laboratory mouse, offering clues to how all sorts of living organisms behave genetically, with potentially widespread applications for agriculture, medicine, and energy.

The *Arabidopsis* Genome Initiative (AGI) is a collaboration of research groups in the U.S., Europe, and Japan funded by government agencies, including NSF. Because it is a model for over 250,000 other plant species, *Arabidopsis* is yielding insights that scientists are already applying to make other plants easier to grow under adverse conditions and healthier to eat.

The complete sequence of *Arabidopsis* is directly relevant to human biological functions because many fundamental life processes at the molecular and cellular levels are common to all higher organisms. *Arabidopsis* contains numerous genes equivalent to those that prompt disease in humans—ranging from cancer to premature aging. To help researchers capitalize on the genome sequence, NSF has begun a “2010 Project” to determine the function of 25,000 *Arabidopsis* genes.

The applications of this project are not confined to biology and medicine. Plants hold great potential as sources of renewable energy, although they currently represent just 3 percent of U.S. energy resources. Studying the *Arabidopsis* genome sequence is revealing how photosynthesis converts solar energy and carbon dioxide into biomass, helping scientists develop better plants for fuel and chemical uses.

Another NSF-funded team of scientists has completed the genome sequence of *Halobacterium* species NRC-1, a microorganism that is among the most ancient forms of life. The achievement is especially significant due to this bacterium's widespread use as a model for genetic manipulation.

The research was led by microbial geneticist Shiladitya DasSarma at the University of Massachusetts at Amherst in collaboration with molecular biotechnologist Leroy Hood at the Institute of Systems Biology in Seattle. DasSarma and Hood led a consortium of researchers from 12 universities and research centers in the U.S., Canada and the U.K. on the 3-year project. *Halobacteria* convert sunlight to energy, giving off a red byproduct whose light sensitivity makes it commercially useful in possible applications such as information storage for computers.

These tiny creatures will provide many insights into how more complex creatures manage life functions, including cell division, and the way cells transport proteins across biological membranes. Several biomedical applications using *Halobacterium* are now being investigated, including the development of orally administered vaccines and the design of new antibiotics.

World Trade Center Response: Following the September 11 terrorist attacks, NSF responded in record time to fund several studies on the engineering, communications, and psychological implications of those events. In December 2001, a team of scientists from Rensselaer Polytechnic Institute headed to the site of the WTC attacks to study how New York's utility companies worked together to quickly restore water, power, transit and phone services. A team from Northern Arizona University is studying how individuals respond to collective loss. Results from the study may aid intervention efforts directed at coping with catastrophic events. The knowledge obtained from Ground Zero can help prevent future tragedies by enabling construction of buildings more resistant to earthquakes, bombs, and other catastrophic forces.

Small Streams Contribute Far More Than Previously Thought to Cleaning Waterways: Small streams remove more nutrients such as nitrogen from water than do their larger counterparts, according to researchers who have applied sampling methods developed in a NSF Arctic area ecological study. The finding could have important implications for land-use policies in U.S. watersheds from the Chesapeake Bay on the East Coast to Puget Sound in the West. The findings are based on data collected from streams in NSF's Arctic Tundra Long-Term Ecological Research (LTER) site in Alaska. Excess nitrogen can cause

ecologically damaging effects in large waterways, including algae blooms, because the nutrients are transported downstream and collect there. According to the research, the smaller the stream, the more quickly nitrogen can be removed and the less distance it will be transported down the stream. "There's a very strong relationship between the size of a stream and how rapidly that stream removes nutrients," said Bruce Peterson of the Ecosystems Center at the Marine Biological Laboratory in Woods Hole, MA. Peterson notes that, collectively, the new studies provide a radically different picture of the role of small streams in contributing to existing nutrient loading. By placing tracers in smaller streams, the researchers discovered how quickly nutrients were assimilated and processed by organisms that live on the streambeds. Peterson argues that the finding could have important implications for land use policies. In many agricultural areas, for example, small streams are often covered to allow ease of access for tilling and working fields. The covering, in effect, creates a dark pipe that inhibits the stream's ability to scrub excess nutrients. Taking greater care to insure that small streams can work effectively to clean the water will reduce the overall nitrogen load that makes its way into larger bodies of water.

Earliest Human Ancestors Discovered in Ethiopia: Anthropologists have discovered the remains of the earliest known human ancestor in Ethiopia, dating to between 5.2 and 5.8 million years ago and which predate the previously oldest-known fossils by almost a million years. The previous discovery of the 4.4-million-year-old *Ardipithecus ramidus* was up to this point the oldest known hominid, the primate zoological family that includes all species on the human side of the evolutionary split with chimpanzees. The fossil finds were made by NSF-funded scientists over a four-year period in Ethiopia's Middle Awash study area, about 140 miles northeast of the capital, Addis Ababa. To the team of scientists, the discovery represents more evidence to confirm Darwin's conclusion that the earliest humans, or hominids, arose in Africa. The area where this hominid discovery took place has been the focus of much recent attention. Eleven hominid specimens have been recovered from five late Miocene localities within the Middle Awash region. The researchers explain that about six million years ago, the Middle Awash region was already a well-defined rift valley characterized by intense earth movements, with active volcanoes nearby. The researchers estimate the size of the skeletal bones and the lower jaw is roughly the same size as a modern chimpanzee.

New Grid Portal to Improve U.S. Researchers' Access to Advanced Computing Resources: Computational scientists will soon have a powerful new tool for using resources on the national "grid" of high-performance research networks. The Web-based grid portal will help computer scientists, scientists and engineers by simplifying and consolidating access to advanced computing systems supported by NSF and its Partnerships for Advanced Computational Infrastructure (PACI). "The collaboration efforts mean that computational scientists will have access to machines supported by the National Partnership for Advanced Computational Infrastructure (NPACI), the National Computational Science Alliance (NCSA), Pittsburgh Supercomputing Center, and NASA, provided that they have accounts," said Richard Hilderbrandt, NSF program director for the PACI program. "The complementary efforts of the PACI partnerships have made the PACI grid portal a reality." Representatives from NPACI, the Alliance, and NASA IPG have conducted a series of workshops targeting specific technologies and resources to include in the effort to demonstrate computational science portals using the high-end systems made available by each organization.

The portal integrates many leading-edge grid technologies being developed by the PACI program, and through continued collaboration, future releases of the portal will integrate additional PACI technologies, such as the Network Weather Service and the SDSC Storage Resource Broker. NPACI unites 46 universities and research institutions to build the computational environment for tomorrow's scientific discovery. PACI also provides operational support to the National Computational Science Alliance (NCSA), which is a partnership to prototype, an advanced computational infrastructure for the 21st century and includes more than 50 academic, government and industry research partners from across the United States.

Research Network Brings Wireless Internet to Native American Reservations: Researchers at the University of California, San Diego (UCSD) are using the latest solar-powered wireless technology to help a pair of Native American tribes bridge the digital divide. The High Performance Research and Education Network (HPWREN) is overcoming geographical, social and technical barriers to bring high-speed Internet access to the La Jolla and Pala tribes.

In remote San Diego County, HPWREN's 45Mbps (million bits per second) wireless backbone connects the low-lying San Diego coastline with the county's mountainous eastern region, home of the La Jolla and Pala Native American reservations. This outreach is funded by NSF as part of an experimental wireless network. UCSD received a \$2.3 million NSF award in August 2000 to create, demonstrate and evaluate a prototype wide-area network for research and education. Connecting the Native American communities posed special challenges for the team lead by computer scientist Hans-Werner Braun and geophysicist Frank Vernon of UCSD. Foremost among these is the rugged terrain where the reservations are located—ranging from valleys with elevation of 2,000 feet above sea level to mountain peaks at 5,000 feet. "There are no line-of-sight views of existing microwave towers from the sites," Braun said. "And in the case of La Jolla, we didn't even have access to electric grid power on the mountain ridge edge of the reservation." The project is an interdisciplinary effort to design a network that—though experimental—is robust enough to be relied upon by researchers under even very adverse conditions, including catastrophic earthquakes. HPWREN is developing such a system for geophysicists, astronomers and ecologists, while demonstrating that the same tools can connect under-served educational users at remote locations like the Pala and La Jolla reservations."

Molecular Rulers Make Nano-Scale Gaps: Scientists at Pennsylvania State University have developed a precise method for making nano-sized metal wires spaced very close to each other. The process could speed the miniaturization of electronic devices used for circuits, high-density data storage and sensors. Anat Hatzor and Paul Weiss fabricated wires that range from 15 to 70 nanometers wide and a few micrometers long and are spaced 10 to 40 nanometers apart. Previously, nano-scale construction methods had been limited to structures with larger, less controlled spacings. The scientists used organic molecules as "molecular rulers," expanding the molecules into nano-scale structures with precise amounts of spacing between them, then using those spaces as miniature molds for gold wires. The ability to create precisely sized, parallel nano-wires simultaneously is expected to be useful in the development of molecular electronics, in which molecules connected by such wires will serve as transistors, switches and other electronic devices. The research was funded by NSF, the Army Research Office, the Defense Advanced Research Projects Agency and the Office of Naval Research. It was conducted at one of NSF's National Nanofabrication Users Network facilities that provides the research and industrial communities with infrastructure and equipment to make nano-scale devices in small quantities.

Team Finds Ancient X-Rays from the Farthest Quasar: A team of U.S. and European astronomers has detected x-rays from the most distant quasar on record. The x-rays, detected with the XMM-Newton satellite, came from a quasar with a redshift of 5.8—which means the x-rays were emitted when the universe was less than one billion years old. The NSF-supported team, led by Niel Brandt of Pennsylvania State University, is using x-ray observations to study some of the oldest and hottest objects in the universe to learn more about how the first quasars and galaxies were formed. The ancient radiation provides a glimpse of the universe shortly after the dawn of the modern universe. Quasars can emit 1,000 times the energy of our entire galaxy and are believed to be fueled by supermassive black holes that in turn are powered by material from their host galaxies.

How Cold is Cold? Scientists Now Know For Sure: Thirty-five years ago, a University of Florida physics professor suggested a new way to measure very low temperatures—that is, temperatures so cold they were off the official scale, which at that time stopped at 0.65 Kelvin. E. Dwight Adams and graduate student Richard Scribner, with support from NSF, created a new type of thermometry by determining the pressure and temperature needed to freeze helium-3. As more and more research was performed in extreme cold,

scientists used this method to gauge temperatures that sometimes approached 0 degree, the theoretical absolute zero.

Now, the International Commission on Weights and Measures has officially adopted the Adams' "melting pressure thermometry" gauge as the worldwide standard for measuring the ultra-cold. Adams' research in magnetism and ultra-low temperatures spans more than three decades, dating to his invention, with graduate student Gerald Straty, of the pressure gauge that allowed the measurements to be made. He now serves as director of a user facility at the NSF National High Magnetic Field Laboratory at the University of Florida, the Nation's premier facility for research into magnetism.

On First Science Cruise Icebreaker Healy Steams to Arctic to Study Crust Formation: Researchers funded by the National Science Foundation (NSF) sailed on the maiden scientific voyage of the U.S. Coast Guard's newest icebreaker to study one of the world's slowest growing oceanic ridges, with an eye to understanding how the Earth's crust forms. The USCGC *Healy*, which is outfitted as a scientific research vessel, carried out the Arctic Mid-Ocean Ridge Expedition (AMORE) from late June until early October 2001. The *Healy* later sailed with the German research vessel *Polarstern*, to sample and study the Gakkel Ridge, a little known geological feature in the Atlantic Ocean. Among the important milestones from the cruise, scientists discovered an as yet unexplained "discontinuity" of volcanic activity along the Gakkel Ridge. Most surprisingly, a dredge team recovered fresh sulfides that apparently are part of "black smoker" chimneys, the most striking manifestation of hydrothermal activity. While the heated water from the hydrothermal vents does not significantly affect ocean temperatures, the vents have attracted the attention of both biologists and geologists. Hydrothermal vents on mid-ocean ridges in the world's oceans provide chemical energy that supports exotic life forms and large ecosystems far removed from the Earth's sunlit surface, where photosynthesis forms the base of the food chain. The discovery of these signs of hydrothermal vents indicates that they may be present in abundance in the Arctic Ocean.

Animated 3-D Boosts Deaf Education: A pool of Internet-enabled virtual people, animated in 3-D, translates English into sign language. Through SigningAvatar™ software, developed with assistance from the NSF's Small Business Innovation Research (SBIR) program, each "person" displays a distinct personality and natural facial expressions that help interpret words and phrases for hearing-disabled viewers on their computer screens. The software represents a step forward in providing universal access to technology and in helping deaf and hard-of-hearing children to develop language and reading skills. "Deaf children face considerably more difficulty than hearing children learning to read," said Edward Sims, chief technology officer of VCom3D of Orlando, Fla., which is marketing the assistive technology. "Our virtual signing interpreters help narrow that gap." The software has been praised by teachers of the deaf and experts in computer technology for putting virtual 3D technology, widely used in video games, to use for educational purposes. SigningAvatar™ is used in several Florida school districts and at schools serving deaf students around the country. "Lots of educational software teaches through voice communication," said Sara Nerlove, NSF's program manager. "This is one of the first compelling uses of computer animation technology to benefit an audience with hearing loss."

The characters interpret words, sentences and complicated concepts into sign language, combining signing, gestures and body language to simulate natural communication. The animations are based on in-depth research of how both hearing and deaf persons use the face and body to communicate. The interpreters include digital teenagers with unique personalities, such as red-haired Andy and 13-year-old Tonya, and a cyber-lizard named Pete. Besides translating printed text, they "tell" stories, ask follow-up questions and hold interactive conversations with viewers. Their vocabulary includes more than 3,500 words in English and in "Conceptually Accurate Signed English," which includes elements of American Sign Language.

New Database to Save Endangered Languages: The emergence of English and Spanish as the dominant languages of global commerce is causing many other tongues to fall into disuse. This trend alarms social scientists worldwide because linguistic research not only provides cultural information, but also insight into the diverse capabilities of the human mind. To combat the decrease in the number and diversity of

languages and to capitalize on a growing store of digitized linguistic data, a team of NSF-funded researchers led by Anthony Aristar at Wayne State University is developing an endangered languages database and a central information server that will allow users to access the material remotely by computer. A \$2 million NSF grant to Aristar and his colleagues at Eastern Michigan University, the University of Pennsylvania and the University of Arizona will be used to create this public digital archive.

The Electronic Metastructure for Endangered Languages Data (E-MELD) project will collect data on endangered languages and devise a Web-based protocol so that new and existing data will be accessible to researchers and native speakers everywhere. The researchers on the E-MELD project will start with 10 distinct endangered languages to design a system modeled on the Internet, where standard communications protocols allow users to access information housed on a variety of very different operating systems, including UNIX, Windows-NT, and VMS. The first version of E-MELD is expected to appear online this fall.

C. MANAGEMENT INTEGRITY: CONTROLS, COMPLIANCE AND CHALLENGES

The Federal Managers' Financial Integrity Act of 1982 (FMFIA) requires an annual review of the adequacy of NSF program and activity management controls. The NSF Management Controls Committee (MCC), chaired by the Chief Financial Officer, is responsible for the oversight and reporting of the Foundation's management and internal control program to the NSF Director on an annual basis.

The MCC requires that individual offices provide assurance statements each year on the FMFIA reviews within their own organizations on program and activity management controls. Individual assurance statements from each of NSF's Assistant Directors and Staff Office Directors serve as the primary basis for NSF's assurance that management controls are adequate (Section 2 of FMFIA), and that NSF systems are in compliance with all applicable laws and administrative requirements, including OMB circulars A-123 A and A-127 and Section 4 of FMFIA. The MCC asserted to the NSF Director that agency management controls and financial management systems taken as whole provide reasonable assurance that the objectives of FMFIA were achieved for FY 2001. It was also determined that agency assets were properly safeguarded.

Consistent with the provisions of the Reports Consolidation Act of 2000, and with the approval of the Office of Management and Budget, the results of NSF's management evaluations required by FMFIA for the period ending September 30, 2001 are included here. During the FY 201 management evaluation process, the MCC did not identify any material weaknesses as defined by OMB guidance. However, as in prior years, the MCC reported several management challenges identified through the FMFIA assessment process. These management challenges do not impact the internal controls of the Foundation, but warrant attention of senior management in order to maintain the long effectiveness of operations at NSF.

They include issues related to human capital; awards monitoring; costing and cost sharing review; system and data management; and security. The MCC will address these issues, most of which require long-term attention.

The independent auditors assert that their finding of information security weaknesses compels a finding of noncompliance with the Federal Financial Management Improvement Act (FFMIA). NSF management does not concur with this assertion for reasons fully discussed in the auditor's report. The Director of NSF has determined that the National Science Foundation is in substantial compliance with FFMIA.

The Director's Statement of Assurance for FY 2001

Based on internal management evaluations and the independent auditor's report, it is my determination, with reasonable assurance, that the National Science Foundation is in compliance with the Federal Managers' Financial Integrity Act. Additionally, I find that the National Science Foundation is in substantial compliance with the Federal Financial Management Improvement Act.

The NSF Management Controls Committee, under the guidance of the agency's Chief Financial Officer, provides senior executive attention to management control issues. Through its representation on the Management Controls Committee, the Office of the Inspector General continues to provide constructive suggestions for improving the agency's management controls and financial management policies and practices.

Rita R. Colwell

IG's Statement of Management and Performance Challenges

As required by the Reports Consolidation Act of 2000, this report includes a statement by the Inspector General (IG) addressing NSF's most serious management and performance challenges; see section on "Other Reporting Requirements." The Director's response follows the IG's statement.

D. DISCUSSION AND ANALYSIS OF THE FINANCIAL STATEMENTS

The National Science Foundation is committed to providing quality financial management to all our stakeholders. We honor that commitment by preparing annual financial statements in conformity with generally accepted accounting principles in the United States and then subjecting the statements to an independent audit to ensure their reliability in assessing the performance of NSF. The results are an opinion on the fair presentation of those financial statements.

FY 2001 Financial Statement Audit

The Chief Financial Officer's Act of 1990 (P.L. 101-576) requires that NSF prepare financial statements to be audited in accordance with Government Auditing Standards. The NSF Inspector General is statutorily responsible for the manner in which the audit of NSF's financial statements is conducted. KPMG LLP, an independent certified public accounting firm, was selected by the NSF Inspector General to perform the audit of NSF's FY 2001 financial statements.

For FY 2001, NSF received an unqualified opinion that the principal financial statements were fairly stated in all material respects. The independent auditors did not report any material weaknesses.

The independent auditors did note two reportable conditions in their report on internal controls related to information security weaknesses and grant monitoring. NSF management does not concur with the assertions made in these findings and provided a response in the audit report. Nonetheless, management has corrected the security weaknesses identified and has identified grant monitoring as a management challenge that merits continued attention and improvement.

The independent auditors' report noted one instance of noncompliance with laws and regulations. Their report found NSF non-compliant with FFMIA based on the information security reportable condition. NSF management does not concur with the non-compliance determination and provided a response in the audit report. The Director of NSF has found the agency to be substantially compliant with FFMIA.

Understanding the Financial Statements

NSF's current year financial statements and notes are presented in a comparative format providing financial information for FY 2000 as well as for FY 2001. Comparative financial statements are required for FY 2001 by OMB 01-09, *Form and Content of Agency Financial Statements*, dated September 25, 2001. NSF elected early implementation of comparative financial statements in FY 2000.

The following provides a brief description of the nature of each required financial statement and its relevance to NSF. Some significant balances or conditions on each statement are noted to help clarify their link to NSF operations.

Balance Sheet: The Balance Sheet presents the combined amounts available for use by NSF (assets) against the amounts owed (liabilities) and amounts that comprise the difference (net position). Three line items represent 99 percent of NSF's current year assets.

Fund Balance With Treasury is funding available through the Department of Treasury accounts from which NSF is authorized to make expenditures and pay liabilities. *Property, Plant and Equipment* comprises capitalized property located at NSF headquarters and NSF-owned property in New Zealand and Antarctica that support the United States Antarctic Program. *Advances* are funds advanced to NSF grantees, contractors and minor amounts to NSF employees.

Accounts Payable and *Advances From Others* represent 96 percent of NSF's current year liabilities. *Accounts Payable* includes liabilities to grantees for their unreimbursed expenses and liabilities to NSF

vendors for unreimbursed goods and services received. *Advances From Others* are amounts advanced to NSF from other federal entities for the administration of grants on their behalf. NSF maintains the expertise and automated systems for the administration of research grants upon which other federal entities rely to assist in the administering of their grants.

Comparative Discussion: Analysis of significant changes from FY 2000 to FY 2001 incorporates an increase in *Fund Balance With Treasury*; *Intragovernmental Accounts Receivable*; *General Property, Plant and Equipment*; *Advances from Others*, *Other Intragovernmental Liabilities*; and *Lease Liabilities*.

The increase in FY 2001 *Fund Balance with Treasury* was in correlation to the overall increase in budget authority. Our appropriated funds increased by approximately 13 percent. The FY 2001 *Intragovernmental Accounts Receivable* increase stems from military receivables. *General Property, Plant and Equipment* increased in FY 2001 mainly through additions to construction in progress related to polar program operations. These additions will eventually result in increase to our buildings and other structures. The increase in *Advances from Others* is attributable to an increase in reimbursable activity with the Department of Energy and NASA. The decrease in *Intragovernmental Liabilities* was primarily due to the payment at the beginning of FY 2001 of an interagency On-line Payment and Collection (OPAC) liability outstanding at the end of FY 2000. *Lease Liabilities* will see a gradual reduction over the next several years and eventually will be eliminated. As a business practice, NSF has changed its policy to purchase in-house equipment instead of leasing.

Statement of Net Cost: This statement presents the annual cost of operating NSF programs. The gross cost less any offsetting revenue for each NSF program is used to arrive at the net cost of specific program operations. Revenues are recognized from other federal agencies for grant administration work, which is completed during the year.

Almost 96 percent of all current year NSF costs incurred were directly related to the support of NSF People, Ideas and Tools programs. Costs incurred for indirect general operation activities such as salaries, training, activities related to the advancement of NSF information systems technology, and Inspector General activities account for approximately 4 percent of the total current year NSF net cost of operations. NSF's commitment to administrative efficiency is evident in the relatively small portion of its total costs devoted to general operation activities.

Comparative Discussion: Analysis of changes in Net Cost from FY 2000 to FY 2001 shows about a 6 percent increase in Net Cost of Operations. This increase is reflective of the agency's overall increase in Budget Authority.

Statement of Changes in Net Position: This statement presents those accounting items that caused the net position section of the balance sheet to change from the beginning to the end of the reporting period.

Consistently, 99 percent of all financing sources are comprised of appropriated funds from Treasury accounts and donations received from private and foreign government sources used in the furtherance of the mission of the Foundation. The increase in unexpended appropriations is due mainly to an increase in unliquidated obligations from the prior fiscal year. Unliquidated obligations are obligations maintained by NSF for research and education for which expenses have not yet been recognized.

Comparative Discussion: Analysis of changes in Net Position from FY 2000 to FY 2001 indicates a 17 percent increase in ending Net Position. This change is largely due to an increase in unexpended appropriations or the amount of appropriation funding remaining at year-end. This increase is consistent with the overall increase to our Budgetary Authority. Another item of note is *Transfers in*. *Transfers in* for FY 2001 relate to the salvage value of the satellite received from NOAA.

Statement of Budgetary Resources: This statement provides information on how budgetary resources were made available to NSF for the year and the status of those budgetary resources at year-end. The outlays

reported on this statement reflect the actual cash disbursed for the year by Treasury for NSF obligations. Most obligations incurred by NSF are for science and engineering grants. This statement is in accordance with the President's Budget.

Comparative Discussion: Analysis of changes in Budgetary Resources from FY 2000 to FY 2001 shows a 14 percent increase in *Budget Authority* and a 6 percent increase in *Total Outlays*. Both of these increases are consistent with our increase in appropriated funds.

Statement of Financing: This statement provides reconciliation between the resources available to NSF to finance operations and the net cost of operating NSF programs. *Net Cost Capitalized on the Balance Sheet* are additions to capital assets made during the fiscal year. *Costs That Do Not Require Resources* include depreciation and the operating gain or losses recognized upon the disposition of NSF capital assets. *Change in Financing Sources Yet to be Provided* discloses the net change or increase in liabilities that are not covered by current budgetary resources.

Comparative Discussion: Analysis of changes in financing from FY 2000 to FY 2001 revealed an increased in *Change in Unfilled Customer Orders* that occurred due to a significant effort in FY 2000 to resolve 1999 unfilled customer orders. The FY 2000 change in unfilled customer orders is characteristic of normal activity. An increase in *Net Costs Capitalized on the Balance Sheet* related to major additions to construction in progress, normal equipment purchases and initial capitalization of software in FY 2001; and a gain on *Disposition of Assets* is being shown to reflect disposition at auction for some items retired.

Stewardship Investments: Stewardship investments are NSF-funded investments that yield long-term benefits to the general public. NSF investments in research and education yield quantifiable outputs shown in this statement as the number of awards made and the number of researchers and students supported in the pursuit of discoveries in science and engineering and in science and math education.

Comparative Discussion: Analysis of changes in stewardship investments from FY 2000 to FY 2001 showed consistent incremental increases in research and human capital activities in support of NSF's overall mission as reported in monetary investments and measured outputs and outcomes.

Budgetary Integrity: NSF Resources and How They Are Used

NSF is funded primarily through five Congressional appropriations that totaled \$4.4 billion in FY 2001, a 13.1 percent increase from the prior year. Other FY 2001 revenue resources include \$115.6 million in reimbursable authority and appropriation transfers from other federal agencies and \$28 million in donations to support NSF activities. Additional resources were also received from the Department of Justice under the American Competitiveness and Workforce Improvement Act, enacted in 1998, which provides for a temporary increase in access to skilled personnel from abroad under the H-1B visa program. In FY 2001, NSF received \$78.5 million from H-1B visa fees, to support education activities and scholarships for financially disadvantaged students in computer science, engineering, and mathematics.

NSF's FY 2001 obligations totaled \$4.5 billion. As indicated in the Statement of Net Cost, the Foundation made investments in education and fundamental research in support of its three strategic outcome goals of People, Ideas and Tools.⁷ Administrative support for the Foundation as a whole is provided by the Salaries and Expenses appropriation. The Office of Inspector General is funded under its own separate appropriation.

For FY 2002, Congress has appropriated \$4.8 billion to NSF, an 8.2 percent increase from the prior year. In addition, it is estimated that NSF will receive \$90 million from the collection of visa fees under the H-1-B program. Key priority areas of focus in FY 2002 include Biocomplexity in the Environment;

⁷ See page 8 for a discussion of how NSF's appropriations are linked to NSF's GPRA performance goals.

Information Technology Research; Nanoscale Science and Engineering; and Learning for the 21st Century Workforce. Core research activities being supported include interdisciplinary mathematics research and plant genome research. Ongoing support is also being provided for major research instrumentation and science and technology centers. A new Math and Science Partnership program encourages colleges and universities to develop partnerships with local K-12 school districts, to improve science and math education. The Noyce Scholarship program, designed to encourage undergraduate students in mathematics, sciences and engineering, to pursue teaching careers, offers scholarships to those students in exchange for commitments to teach in elementary or secondary schools. In an effort to attract the most promising students to pursue graduate studies in science and engineering, graduate fellowship stipends are being increased to a level of \$21,500. Finally, among the large infrastructure projects being supported in FY 2002 are a terascale computing system, the Atacama Large Millimeter Array radio telescope and the Large Hadron Collider.

Future Business Trends and Events

NSF is continually evolving as we focus on new priorities and challenges. The future will require NSF to focus on demonstrating management excellence through sharpened attention to specific issues. For example, the *President's Management Agenda* mandates that NSF, like other agencies, demonstrate consistent results through proven management practices in Human Capital Management; Achieving eGovernment; Competitive Sourcing; Financial Management; and Integrated Budget and Performance Management. In addition, the agency also pro-actively addresses management challenges identified through internal review and oversight as well as those identified by the agency's Inspector General and the General Accounting Office. Some of the areas NSF will focus on in both the immediate future and long term are:

- **Financial Performance.** NSF, although receiving high marks from the Office of Management and Budget for our ability to maintain, control and report the financial position of the agency, will need to seek continued improvement as outlined by the President's Management Agenda. NSF, along with other federal agencies, will be pursuing future financial performance issues of accelerated financial statement reporting; risk and cost/benefit assessments of erroneous payments; cost and performance information integration; and financial systems that routinely produce information for operational and investing decisions. NSF also will need to address the audit findings resulting from the year 2001 financial statements through the coming year. NSF is positioned to accept the challenges by increasingly leveraging technology to meet the demands of new or existing legislative requirements. However, NSF projects that in order to meet ever increasing demands in accountability and improved timeliness of financial data, more financial and human capital resources will be required in order to maintain our standards of excellence.
- **Human Capital Planning.** The nature of science and engineering research and education at an ever-changing frontier demands unique knowledge agility in the NSF workforce. The agency maintains this characteristic by capitalizing upon current staffing flexibilities such as the Intergovernmental Personnel Act to complement its permanent workforce. By so doing, it develops a cohort of visiting scientists and engineers who typically spend one to three years with the agency. These individuals motivate innovation in perspective and stimulate science and engineering investments that may not occur otherwise. Following their NSF assignments, these researchers and educators return to their home organizations with an informed perspective on national science and engineering priorities and federal investments in science and engineering research and education. They also serve as a reserve workforce to call upon in the future as the need arises.

To sustain its high-performing workforce, NSF is exploring ways to provide a flexible, motivating work environment and to recruit and retain excellent employees. New initiatives include an updated telecommuting program; strategic recruiting techniques that also seek to increase representation of underrepresented groups in the NSF science and engineering workforce that reflects the diversity goal

in the agency's FY 2002 GPRA annual performance plan; a renewed focus on continuous learning; and an increased emphasis on leadership and succession planning.

- Expand an Electronic NSF. NSF is one of the founders and partners of the Federal Commons initiative, a project led by the Department of Health and Human Services/National Institute of Health to develop electronic systems to support grants processes for the science and engineering research and education community. NSF is committed to the new government-wide E-Grants Initiative. While other agencies are planning for electronic grant submissions, in October 2000, NSF started conducting virtually all business interactions and transactions electronically with the grantee community through its "FastLane" grants system.

The NSF FastLane system exemplifies what can be achieved in eGovernment information system design, development and implementation. In June 2001, NSF implemented electronic signatures for proposals which enabled the complete electronic submission of proposals. So far nearly 20,000 electronic signatures have been collected. Virtually all of NSF's external customers—scientists, engineers, educators, technology experts and academic administrators—use FastLane's Web-based system for a variety of tasks—to submit proposals, to conduct peer-reviews, or to submit awardee progress reports. Universities and other organizations request funding increments and report on billions of dollars in expenditures through this system. In addition, the public can access titles, authors, funding amounts and abstracts of NSF awards.

NSF has also contributed time and resources to develop a significant part of the Federal Commons, the Government-wide grants portal, and remains active in supporting the eGrants initiative approved by the President's Management Council. For example, NSF created a generic federal grants Web prototype for use by all federal grant-making agencies as part of the Federal Commons. Turned over to the Federal Commons in October 2001, the Web-based grant submission program uses XML to transmit the submitted data to federal agencies and other participants. NSF is a leader of electronic government and will continue to commit its expertise, experience, and technologies to leverage best practices in the future inter-agency eGrants initiatives.

- Competitive Sourcing. For many years NSF has leveraged the potential of competitive sourcing to achieve its mission. While the agency is comparatively small and has a federal workforce of only about 1,200, many times that number are involved each year in realizing the agency's goals.

NSF has competitively sourced its commercial administrative functions, including its mailroom, copy center, health unit, travel center, and much of its software and systems development. A high level of competitively sourced commercial activities over the years has enabled NSF to focus its small workforce on its core business needs and mission-essential functions. Although NSF's budget has increased by more than 80 percent in the past ten years, the number of NSF employees has remained virtually flat, due in part to the agency's effective use of competitive sourcing. NSF will continue to pursue cost-effective means of competitive sourcing as future trend of maintaining a high operating efficiency.

Limitations of the Financial Statements

Responsibility for the integrity and objectivity of the financial information presented in the financial statements lies with NSF management. The accompanying financial statements are prepared to report the financial position and results of the operations of NSF, pursuant to the requirements of Chapter 31, of the United States Code section 3515 (b). While these statements have been prepared from the books and records of NSF in accordance with formats prescribed in Office of Management and Budget guidance on *Form and Content of Agency Financial Statements*, these financial statements are in addition to the financial reports used to monitor and control budgetary resources which are prepared from the same books and records. The financial statements should be read with the realization that NSF is an agency of the executive branch of

the United States Government, a sovereign entity. Accordingly, unfounded liabilities reported in the statements cannot be liquidated without the enactment of an appropriation, and ongoing operations are subjected to enactment of appropriations.

